Modern technologies of waste utilization from industrial tire production

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Modern technologies of waste utilization from industrial tire production

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Abstract. The innovative technology of waste tire production recovery from JSC "Nizhnekamskshina", which determines the possibility of obtaining a new type of composite material in the form fiber filled rubber compound (FFRC) as the raw material, production of rubber products with high technical and operational characteristics.

The development of modern waste technology from industrial production determines to comply the federal laws such as "About environmental protection" (Federal Law №219 from 21.07.2014),"About energy saving and energy efficiency improvements and about amendments to certain legislative acts of Russian Federation" (Federal Law №261 from 23.11.2009).

In the present project technological wastes are considered as secondary material resources used in the recycle mode of technological processes of redistribution with production of high quality products.

The problem of waste production is relevant for a number of ecological and economic factors, such as reduction the impact on the environment, increase energy and resource efficiency of the production process, insurance the possibility of commercialization of the waste at the newly created market consumption, the organization of commercial production in the operation of waste recovery.

Industrial production processing of polymeric materials (for example, the production of car tires) are associated with the formation of a very specific production waste in the form of the rubber polymer edged cord or steel cord. During the formation of the tire on the molds with the layering of flat rubberized cord is formed with their shotguns dimensional parameter and configuration unsuitable for the production of primary products. At the same time, cutting rubberized cord retain their physical and mechanical properties that are typical of the raw material in the production of rubber-technical products, which determined the urgency of solving the problem of the process of development of this type of waste recovery with purchase of the raw material specified quality index.

The result of research and development in the development process waste tire production (JSC "Nizhnekamskshina") defines an innovative technology to produce a new type of composite material - fiber-filled rubber compound (FFRC), which is a composite raw material for the production of rubber products with high physical and mechanical operation.

The proposing technology of waste products recovery through the use of rubberized cord edges has the following advantages:

1. At present, wastes formed during the production of tires as rubberized cord edges are giving to combustion in thermoovens, which is associated with the costs to capture pollutants of second and

third categories of danger and payments for emissions. There is a significant turnover of material resources.

2. In the case of giving these wastes to consumers the costs of waste management are transformed into profits of the enterprise.
3. The use of waste recycling within the company by opening a small enterprise for the production of new material (FFRC) determines the conditions to expand the market of products, lays the technological possibilities of manufacture of alternative kinds of rubber goods. In particular, it is possible to ensure that import substitution in the oil producing enterprises (OJSC "Tatneft") through the production of high-quality V-belts for oil rocking chairs on the basis of a new type of raw materials - composite fiber-filled rubber compound.

An innovative approach to technology waste tire production to produce a fiber-filled composite polymeric materials defined the development and manufacture of a new patent-protected equipment for dispersion and mixing extruder protected by patent "Device for the preparation of fiber-filled composite polymeric materials" (patent №73269).

The design of the extruder allows grinding rubberized tire cord edges to the desired structural dispersion cords, promotion of small segment to nanostructures and further mixing with a rubber component to obtain a homogeneous composite rubber compound with fine-fiber filled nylon.

Designed extrusion process of obtaining a new type of composite material by utilization of secondary resources of tire production - recovery shotguns rubberized cord realized by conducting design work with the production of a pilot plant - precipitation mixing extruder DSE-1.

Research of performance characteristics of rubber products manufactured on the basis of the produced composite rubber mixture FFRC has been conducted at the Laboratory of elastomers KNIITU with the assessment of the curing properties on the «Reomtr-100S». Compared with caoutchouc rubber mixtures of general purpose rubbers qualitative characteristics on the basis of curing properties of FFRC showed significant positive differences. In particular: conventional tensile strength reaches 22.8 - 24 MPa; elongation 10%; tear resistance reaches 125 - 149%; the Shore hardness value of 92 - 95; rebound resilience of 35 - 37%; loss on attrition is reduced to $(0.03 - 0.04)10^{-3}$ kg.

The tests found that rubber-based FFRC have high wear resistance, high adhesion to the rubber-cord, which ensures a long life design.

Expansion (diversification) Nomenclature RTP based FFRC involves: the ability to produce a wide range of V-belts, flat (ribbed) belts for trucks, agricultural machines, machinery equipment; increased resource exploitation RTP; the ability to manufacture a wide series of V-belts for the oil fields, the engines of automobiles "KAMAZ"; production of high quality components for industrial rubber goods for transport machinery (dampers, pulleys, rollers, scrapers snowplows); Issue wear-resistant conveyor belt; the ability to produce under-rail pads with high resistance to bending and impact strength, able to serve on construction of high-speed railway lines.

The following particular specific properties are achieved with the introduction of high-strength fiber materials: for carbon fiber and kevlar - impact strength, armor; to asbestos fibers - brake wear.

In the direction of applying the results of research the technological capabilities of industrial waste recycling are established on the large-scale production of polymer products, both directly in the production of composite materials, and the resulting application of a new type of raw material in the manufacture of rubber goods (3).

As a result of research on the topic, it was designed and manufactured mold for the production of V-belts series C-4000 for oil rocking chairs. A pilot batch of V-belts C-4000 were field tested in the oil fields of OJSC "Tatneft". V-belts made by the proposed technology have worked 9,000 - 12,000 operating hours (setting of 2 belts), while the belts of the company "Otibelt" (Germany) have the resources of 5000 operating hours with the setting of 3 belts.

In addition to the presented results it should be noted that the scrapers for conveyor harvester "Don" were made from the resulting FFRC which worked for 3 seasons. Whereas, under similar conditions as the traditional rubber scrapers ensure resource for one season.

The proposed technology is concluding the following advantages:

- The majority of production at the plant for the production of industrial rubber goods, including tire plants in Russia (in the cities as Nizhnekamsk, Voronezh, Omsk, Kirov, etc.) and other countries, the solution of problems associated with waste disposal and recycling of secondary material resources. The proposed technology solves these problems;
- In the innovative engineering technology it solves the problem of providing new types of raw materials, which defines the production of a new product with high performance - composite materials;
- By developed technology and advanced equipment it enables the organization of industrial production with innovative technology of manufacture of transmission belts having a world-class quality indicators and a wide area of consumption - oil production, automotive, agricultural mechanical engineering, machine tool equipment.

The proposed technology for their promising direction is determined by the possibility of 100% recycling - as secondary resources for tire factories of the Russian Federation to ensure the production of many kinds of high quality RTP with specific indicators.

Currently, in KFU it is going the research on innovative technology of utilization of metal-rubberized cord edges (MRCE). RTP obtained by MRCE have required level of performance of elasticity, high impact strength, abrasion resistance, armor protection to be penetrated, which are opening up opportunities for the diversification of technology in the fields of mechanical engineering, road construction, military equipment.

As part of this research project, the pilot batch of scrapers for snow plows made from MRCE have passed field trials in winter 2014/15, and will be continued in 2016.

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